

REMARKS

Acknowledgment

Applicant appreciates the Examiner's acknowledgment of receipt of Applicant's election of Group 1 (claims 2-3 and 6).

Applicant appreciates the Examiner's acknowledgment of receipt of papers submitted under 35 U.S.C. 119(a)-(d), and placed of record in the file.

Claim Rejections

Claims 2-4, 6, 8, and 10 are pending in the application, of which claims 4, 8 and 10 are withdrawn from consideration.

Claims 2-3 and 6 are rejected.

35 U.S.C. § 112 rejection

Claim 3 is rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Claim 3 is canceled, and the limitations therein are incorporated into claim 2. Furthermore, claim 2 is amended to recite, in part, "the aqueous solution being stirred continuously throughout the first, second and third steps" to overcome the Examiner's rejection on grounds of indefiniteness.

35 U.S.C. § 102 rejection

Claims 2-3 are rejected under 35 U.S.C. § 102(b) as being anticipated by Nakada et al. (*High-Efficiency Cadmium-free Cu(In,Ga)Se₂ Thin-Film Solar Cells with Chemically Deposited ZnS Buffer Layers*).

Claim 2 is amended to include the limitations of claims 3 and 6, with claims 3 and 6 being cancelled. Claim 2 is further amended to recite, in part, "the buffer layer in the first and second steps being formed by regulating the pH of the aqueous solution in the range of 1 to 3.5 to obtain a deposition rich in InO and the buffer layer in the third step being formed by regulating the pH of the aqueous solution in the range of 3.5 to 12.0 to obtain a deposition rich in InOH-InO, the structure of the buffer layer changing in response to the change in pH." Support

for the amendment is found in the specification at least in paragraphs [0038]-[0042], page 8. No new matter is added.

Accordingly, the quality of the buffer layer is changed by regulating the pH of the aqueous solution in three steps. In practice, the aqueous solution is regulated at a pH of 1.0 to 3.5 (acidic) then it is regulated at a pH of 3.5 to 12.0 (i.e., becoming more alkaline) in the third step. Thus, the initial lower deposition of the buffer layer is rich in InS initially by regulating the pH of the aqueous solution in an acidic range. The subsequent upper deposition of the buffer layer formed in the third step is rich in InOH-InO by regulating the pH of the aqueous solution toward an alkaline range.

It is disadvantageous to increase the thickness of an InS-rich deposition layer because InS has a small band gap and may reduce the optical transmittance of the buffer layer.

On the contrary, the deposition layer being rich in $\text{In}(\text{OH})_3 \bullet \text{In}_2\text{O}_3$, which is obtained by regulating the pH of the aqueous solution toward an alkaline range, has a large band gap and can be used as a transparent conducting electrode layer.

Therefore, it is desirable to form a thicker deposition layer being rich in $\text{In}(\text{OH})_3 \bullet \text{In}_2\text{O}_3$, which can be free from the effects of plasma damage in the process of forming a transparent electrode over the buffer layer and can attain the suitable conformity to the transparent electrode without decreasing the optical transmittance of the buffer layer. Consequently, it becomes possible to obtain a buffer layer having high optical transmittance, high adhesion to the light absorbing layer and suitable conformity to the transparent electrode even when using InS material having a small band gap, making it difficult to pass light of short wavelengths (see, for example, paragraphs [0043]-[0044], page 9).

The cited references do not disclose the above-discussed method of forming a buffer layer by first forming an InS-rich deposition from an aqueous solution by regulating the pH of the solution first to an acidic range and then by forming thereon an InOH-InO-rich deposition by regulating the pH of the solution toward an alkaline range and thus obtaining a buffer layer having a relatively large thickness without decreasing the optical transmittance of the product. Furthermore, the buffer layer is free from the effects of plasma damage in the process of forming

a transparent electrode by sputtering on the buffer layer, attains high adhesion to the light – absorbing layer, and has suitable conformity to the transparent electrode.

Applicant therefore respectfully submits that claim 2 is patentable over Nakada and requests reconsideration and withdrawal of the rejection.

35 U.S.C. 103(a) rejections

Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakada et al. as applied to claim 2, and further in view of Dona et al. (*Chemical Bath Deposition of CdS Thin Films: An Approach to the Chemical Mechanism Through Study of the Film Microstructure*).

As indicated above, Applicant has amended claim 2 to include at least the limitations of claim 3, with claim 3 being canceled. Dona fails to cure the deficiencies of Nakada with respect to claim 2 as amended. The rejection of claim 3 is thereby mooted.

Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakada et al. as applied to claim 2, and further in view of Hashimoto (*Chemical bath deposition of CdS buffer layer for CIGS solar cells*).

As indicated above, Applicant has amended claim 2 to include at least the limitations of claim 6, with claim 6 being canceled. The rejection of claim 6 is thereby mooted.

Hashimoto fails to cure the deficiencies of Nakada with respect to claim 2 as amended. Specifically, Hashimoto teaches deposition of CdS films in solutions that are strictly alkaline (in the starting range of 11.5 – 11.9) in a single step, for a fixed period of time. The pH was measured, but not regulated, as is recited in Applicant's claim 1. Furthermore, the pH remained in a very narrow alkaline range throughout the deposition (e.g., ~10.3 – 12.0) and was not regulated in steps from an acidic range to an alkaline range.

Applicant therefore respectfully submits that claim 2 is still patentable over Nakada in view of Hashimoto.

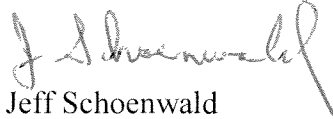
CONCLUSION

In light of the above discussion and now amended claims, it is believed that the remaining pending claim is in a condition for allowance and a notice of the same is requested. Should the Examiner have any questions, requests or suggestions, the Examiner is invited to contact the undersigned at the telephone number indicated below.

The Commissioner is hereby authorized during prosecution of this application and any related appeal, to charge any fees that may be required (except for patent issue fees required under 37 CFR §1.18) or to credit any overpayment of fees to Deposit Account No. 50-0337. If an extension of time is required in connection with this paper, please consider this a Petition therefore and charge any fees required to Deposit Account No. 50-0337.

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Respectfully submitted,



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